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Evolution of Game Music

A look at characteristic elements of music in video games across time

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Evolution of Game Music

A look at characteristic elements of music in video games across time

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Abstract

Music in video games is a subject worth regarding. Nevertheless, it isn't totally explored yet. This thesis shows and explains characteristics every video game music has and explores them regarding the developments in the history of video games. The thesis contains information about video games that inspired the musical evolution of games or that contain music as key part, as well as information about technological advances that influenced the musical evolution.

Contents

List of abbreviations / Glossary

API

...application programming interface, contains information for programmers about communication between several applications.

Arcades

...gaming halls, popular between the 1970s and 2000.

Bit/Byte

...Bits or bytes are units that contain information that can be read by a computer. Every information is saved in a bit. One byte contains eight bits, one kilobyte contains 1024 bytes.

CD-ROM

...Compact Disc - Read-only memory, popular storage medium.

CPU

...Central Processing Unit, main working part of any digital machine.

DAC

...digital-to-analog converter

DSP

...Digital Signal Processing

FM

...Frequency Modulation

FPS

...First-person shooter, game genre.

Handhelds

...portable gaming consoles.

Home Console

...machine to play games at home, typically connectable to a television.

iMuse

...Interactive Music Streaming Engine

MIDI

...Musical Instrument Digital Interface

MMO

...massive multiplayer online, game category.

MOD

...module format, saving format for musical data.

Oscillator

...technical instrument that creates sound waves.

PC

...personal computer

PCM

...Pulse Code Modulation, sampling method.

PSG

...Programmable Sound Generator

RPG

...Role-playing game, game genre.

Sampling

...Process to convert an audio signal into a digital signal that can be used and understood by a machine. A sample contains the data, created by sampling.

SCUMM

...Script Creation Utility for Maniac Mansion; software engine for building adventure games.

SID

...Sound Interface Device, transfers sound data.

Sound channel

...a sound channel delivers a sound signal. Every sound channel can deliver one tone at the same time.

Sound generator

...makes sound and converts it to a musical signal, that can be heard through loudspeakers.

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1 Introduction

“Although battling virtual worlds in high fidelity started to spread from youth into mainstream culture decades ago, the study of music in games is still a research desideratum of media studies and musicology.”[1]

Video games have constantly developed and grown since their early beginnings in the late 1950s. Starting as a simple technological gadget, video games are now a global, multimedial, “ever-evolving”[2] and technologically pioneering industry worth over 24 billion dollars, combined with a huge age and gender independent culture.[3]

Together with the games themselves, the music and graphics evolved significantly within the last 60 years. In fact, some technological advances were empowered by the games industry, developers and players in need of progress.

Surprisingly, this multimedial, booming evolution is not entirely explored yet. Especially the musical developments are not completely investigated so far. But people start to realize the importance of music in video games, and its explanation, which is for example seen on two independent documentaries called “Beep”[4] and “The Player's Score”[5], which are currently in production. Both cover the history, evolution and influence of video game music and are financed through crowd funding (which shows people's increasing interest in this subject). Furthermore, there are various industry groups like the “Interactive Audio Special Interest Group (IAsig)”[6] and the “Bundersverband Interaktive Unterhaltungssoftware (BIU)”[7] which represent the video game music and industry and which support events like exhibitions, to share the subject in public. They want to improve the general performance of games and sound in games and inform about the current market and new developments.

In this thesis, I am going to explore the evolution of game music, with a special interest in characteristic elements of game music. Therefor, I defined characteristics of game music and eras of similar game audio to examine the attributes across time.

To finish this work, I am going to explore the possible future of video game music.

1 Moormann, 2012, p. 7
2 Arem 2012, p. XXI
3 See VHX, 2014, 05:39 – 08:10
4 Ehtonal, c2015
5 Caldwell et al., 2015
6 MIDI Manufacturers Association, c1994-2015
7 BIU, c2015

I define the term “video game” in this work with the words of Karen Collins: “I use the term *video game* here to refer to any game consumed on video screens, whether these are computer monitors, mobile phones, handheld devices, televisions, or coin-operated arcade consoles.”[8]

Furthermore, the term “music” here means every audio signal delivered from or through a video game, including sound effects. If a video game contains actual music as well as sound effects, the difference will be mentioned. The terms “audio” and “sound” (without referring to a sound effect explicitly) are used as synonyms to music in this work.

All information in this thesis is primarily associated to the American and European video games market.

8 Collins, 2008, p. 3, emphasis added

2 Characteristics of video game music

The greatest difference between video games and other entertainment media is the player. The player, or gamer, directly influences what happens on the screen. He or she decides where to go, whom to shoot, what strategy to play – the player is involved in the events and, after all, is the significant reason why a game is a game. Without a gamer, a game could be just a picture or trailer. Therefore, the player himself is the most important and significant characteristic a video game has in general. And as will be shown, the player is also important for the music in video games.

2.1 When is music used in games?

Video game music is, and nearly always was thought out well. The developers, programmers and now composers or sound designers plan every part of the music. In the early years of gaming, planning meant to consider where and how the music could be integrated into the game, remembering the huge limitations given by the technology.

Video game consoles and computers had, compared to today, far less capabilities, especially regarding memory space. Nowadays, the technology is very efficient and even a small USB stick with 16 gigabytes of memory, for example, contains 2048 times[9] the memory of the classical home computer Commodore PET (1977, 8 kilobytes of memory).

Figure 1: Commodore PET, first personal computer, released in 1977

9 1 gigabyte (GB) contains 1024 kilobytes (KB). 16 GB = 8 x 2 GB = 8 x 2 x 1024 KB = 8 KB x 2048

No wonder, that the sound wasn't regarded at all.

In fact, the sound of the massively successful game Pong, that led attention to game sound in general, was “not an aesthetic decision, but […] a direct result of the limited capabilities of the technology of the time.”[10] Nevertheless, Pong made video game audio interesting, which leads to the question: when is music used in games?

This question is directly related to the one asking why music is used in games. As Al Alcorn explained[11], the reasons to implement music weren't always aesthetic. In fact, they were rather functional than aesthetic, and the idea of using music as an actual feature to improve the quality of a video game came along later, hands in hands with technological improvements.

2.2 What music is used?

Video games can be sorted by genre, year, console, bit and many more. They also can be characterized through musical features. Indeed, some games are known or remembered especially for their music, such as Pong (1972) and Tetris (developed 1985, popular with the Nintendo Game Boy in 1989).

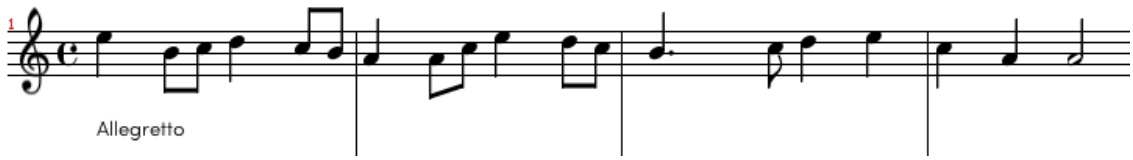

Figure 2: popular Tetris 'Theme A'

The popular melody is based on the Russian folk song “Korobeiniki” and is, nowadays, a popular example of music that is associated with games.[12]

In the early years of video games history, the question what music is used wasn't really important (due to the limitations mentioned earlier). But as soon as the technology allowed so, various music was – and still is – used. In fact, the diversity of musical genres grew significantly, which makes this question very relevant.

In general, there are only four answers to this question, and as will be shown, all of them happen in the video game history.

10 Collins, 2008, p. 9
11 See Collins, 2008, p. 8f
12 Fun fact: the melody also found its way into popular music, the German band “Scooter”, for example, remixed it for a song.

Original music is music that is composed specifically for a certain game. In contrast, licensed or pre-composed music already exists and is merely implemented in the game, sometimes newly arranged or recorded. The third usage of music is the mixture of original and licensed music. And the last kind of music is no music at all, which means that the game is silent.

2.3 How is the music built?

In general, every kind of music shows certain typical structures. For example, most classical symphonies use the sonata form and popular music regularly uses a simple song form containing verses, a chorus and a coda or bridge. Video game music also follows a certain structure.

In the beginnings of the video games industry, the games rather used sound effects than actual music, due to the small memory of the machines. So when it came to the use of music in the form of short, simple melodies, the developers started to use so-called “looping”, to save memory. The musical sequences started over and over again, until the player got to a new area, where another loop began. Instead of or in addition to looping, some games also picked the musical sequences randomly, also in order to save memory. The “loops ranged in length from some seconds to more than one minute depending on the game's genre and the area in which the musical piece was used.”[13] The looping sequences also had a simple typical structure: in general areas, the developers used longer loops, as the player needs some time to challenge them. For boss fights and key sequences, shorter and faster loops were used to increase the tension.[14]

Besides looping, video game audio developers used some compositional techniques known from the film industry. For example, sound effects were sometimes inspired by “Mickey Mousing”.

The technique is named after the popular Mickey Mouse cartoons, in which it is usually a trademark. The sounds follow the characters, so the music goes up when the main character walks upstairs, for example. Therefore, Mickey Mousing creates a certain form of interactivity.[15]

13 Fritsch, 2012, p. 17
14 See Fritsch, 2012, p. 23
15 See Rauscher, 2012, p. 98

Another important practice was – and still is – the mood technique. The music tries to deliver a certain, pre-defined mood to the player with the goal to immerse him or her. Indeed, the mood technique is what makes people cry in the movies.

“Through sound and music, a game can completely immerse a player in another universe or reality. The creative freedom to manipulate moods and environments is limited only by the technical capabilities of the machine and a musician's imagination.”[16]

The third popular composing technique adapted from films are the “leitmotifs”. Nowadays, nearly every movie production works with leitmotifs, which identify certain characters, objects or areas. Many games adapt this successful format, too.[17]

2.4 Role of music in the game

“The role of sound in gaming has evolved since the early 1970s, heavily influenced by developing technologies associated with audio, video, and data storage.”[18]

Indeed, for many gamers, audio in video games became one of the most important reasons for admiring a game, and a feature that is important for the enjoyment of playing. According to Electric Artists, “92% [of players] remember the music from a game even after they've stopped playing it.”[19] One of the reasons for this is that video game music, like in movies, supports the mood and gives the feeling of immersion to the gamer. Due to the huge interactivity in video games, the player builds a relationship to the game and to the music.

“Music also provides a sense of presence and immersion to signify emotional states.”[20] Therefore, it is also important how realistic the music sounds and how realistically it is implemented in the game. Musical events within the game can symbolize something that happens. For example, in a first-person shooter (FPS), the gamer can be forewarned by the music and react immediately to avoid getting hit. Now, if the sound is delayed, the performance suffers. So the sound events need to trigger at the right time, which is only guaranteed if the sound is implemented correctly.

Besides immersion, music in games can have various functions, depending on the game genre, the company and the platform.[21]

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16 Marks, 2012, p. XX
17 See Collins, 2008, p. 130f
18 Grimshaw / Tan / Lipscomb, 2013, p. 636
19 Cited in Collins, 2008, p. 117; the original reference, a white paper published on http://www.electricartists.com, is no longer available due to the website being unreachable as of the time of writing this thesis
20 Grimshaw / Tan / Lipscomb, 2013, p. 655
21 See Collins, 2008, p. 127ff

2.5 How is the music?

Video games in general and their music in particular have many more properties, defining and describing what makes the game special. One of them is interactivity.[22] It is caused by the fact that games don't work without at least two different parties. They may be several players or one player versus computer or machine. In any mode, the parties have to interact, fight, race against each other. And depending on those parties' decisions and actions, the game and gameplay turn out different, which is called interactivity.

Non-linearity is associated with and is probably the most important part of interactivity. It describes the character of video games as not entirely predictable and therefore not linear, unlike movies. The player has to make choices that influence the gameplay directly. That means that every gameplay turns out different.[23] All games are non-linear by definition.

Dynamic audio is related to interactivity. It is basically music that reacts to the gameplay. If the music doesn't show interactivity in any way, it is called non-dynamic. If it does, it can, after Collins, be categorized as interactive or adaptive.[24]

Music in video games is defined as interactive when it “reacts to the player's direct input”[25], so when the gamer triggers the sound events in the game. Adaptive audio is music that changes depending on the state of the game or timed events. It reacts, for example, when the time of the game begins to run out or the health of a character gets lower.[26]

Another version of interactivity in music is given with surround or 3D sound. Surround sound usually comes from within the game in a defined space around the character.

“3D sound brings externalization and directionality to a game's audio by giving the impression that sounds are coming from the three-dimensional space around the player.”[27] Insofar, the direction of the sound signal can give cues to the player (especially for blind players). Surround sound is programmed and available in several formats.[28]

22 See Collins, 2008, p. 3
23 See Collins, 2008, p. 4
24 Ibid.
25 Collins, 2008, p. 139
26 Collins, 2008, p. 4
27 Grimshaw / Tan / Lipscomb, 2013, p. 666
28 See Collins, 2008, p. 72

Games, their music and the referent[29] can also show interactivity in being either diegetic or non-diegetic. The diegesis is the character's space.[30] Diegetic sound is defined as music that happens in the game and that, therefore, “belongs to the game world”[31]. A sound signal from a programmed referent in the game, like the princess in Super Mario Bros. talking to Mario at the end of the game, is diegetic. Diegetic music can be a sound effect or actual music. Diegetic music can furthermore support the immersion of the player into the game. It “refers to the world of the characters and in the environment portrayed on screen”.[32]

Non-diegetic music, in contrast, happens outside the game world or is passive. Common examples are the interface or the background music of a game. Non-diegetic sounds exist to immerse or support the player. He or she hears them, but the character the gamer is playing doesn't. Non-diegetic music also “functions as an interpretive element, guiding the listener toward a certain feeling”.[33]

Of course, video game audio can also merge the characteristics mentioned above, which complicates the terminology. Therefore, the following table based on Collins, 2008 tries to illustrate the possible combinations using examples.

	Diegetic	**Non-diegetic**
Interactive	Sound effects that are triggered by the player and heard by him and the in-game character. Steps and shots in an FPS.	Sound effects that are triggered by the player and heard by him only. Level-up sound or confirmation sound when a player finds something.
Adaptive	Sounds in the game world that are triggered by the game itself. Wolf howls or rooster crows at dawn.	Sound effects outside the game that are triggered by the game itself. Background music changes at dawn.
Non-dynamic	Background noise in a certain area. Fan noises in a racing game or jukebox playing in the background in a bar scene.	Background music in the interface.

Table 1: Interactivity in video game music

29 The referent is whoever triggers an event, usually the player. See Ekman, 2005
30 See Collins, 2008, p. 184
31 Ekman, 2005
32 Grimshaw / Tan / Lipscomb, 2013, p. 655
33 Grimshaw / Tan / Lipscomb, 2013, p. 655

3 Video game musical eras

> "Game sound has progressed from simple, synthesized beeps and one- or two-line melodies utilizing a low-level, hardware-based sound generation process, to stored MIDI tracks incorporating richer, multilayer polyphony, then to the use of actual digital recordings of sound effects and music."[34]

In fact, video game music evolved more than mentioned in the citation. It started out as a non-existing feature of video games. Tennis for Two (1958) and Spacewar! (1962), the very first video games, only gave a short insight into the possibilities of the medium "video game". The possibilities and influences of music weren't regarded at all, as the possibility to play a video game in general was already so incredibly stunning.

3.1 Beep: 1972 – 1977

The history of music in video games actually started with the game Computer Space in 1971 (Nutting Associates). It was a computer game that included battle sounds like explosions. However, the game that made video games and their music successful as an entertainment media form was Pong. The hit was released in 1972 by the influential company Atari. Pong was easy to play and intuitive, but the sound made it a real novelty. When hitting the paddle, the machine made a single "beep" sound. The revolutionary sound was, as mentioned earlier, only a functional sound effect, but it improved the quality of the game incredibly.

Figure 3: 1972 Pong release. From left to right: Ted Dabney, Nolan Bushnell, Fred Marinic and Allan Alcorn.

34 Grimshaw / Tan / Lipscomb, 2013, p. 638

The success of Pong led to several arcade games and home consoles trying to implement sound. Pong itself was released in 1975 as telegame home system, using the same sound as the popular arcade game, of course.

In 1974, the first so-called “rhythm-action” game Touch Me (Atari, 1974) entered the games industry. The player had to repeat beep sequences correctly on four buttons. However, the industry was not yet ready for this kind of game, still exploring technological possibilities in the gaming technology.

In the following two years, four other machines also found their way into the homes of the video game fans.

Atari set the next standard with its home console Video Computer System (VCS, 1977, later also known as Atari 2600). The VCS used the so-called “Stella” sound chip which had two sound channels with 4-bit sound. But games on the VCS didn't use much music because it was difficult to program.[35]

Other consoles were the Channel F (Fairchild, 1976, implemented speakers), and the Studio II (RCA, 1977). Both were not very successful, due to the release of the VCS 2600.

The first game relevant home computer Apple II (Apple, 1977) had only one sound channel capable of beeps, which was intended for warning sounds.

Although the consoles could use music, the games from 1972 to 1977 only used sound effects and short introductory and “Game Over” melodies, due to the small memory and the programming difficulties. The limited memory made it difficult to integrate sound in the game. While playing, the machine needed all of the available space to work correctly. Therefore, sound (effects) in the beep-time could only be played when no other action required memory. Furthermore, sound was really difficult to implement. Every part of the game had to be programmed by hand and coded into the machine's CPU and the sound had to fit into the tiny space.[36]

The music in those early arcade games was very functional. In the noisy, full arcade halls, every machine had to fight for attention. Thus, the machines tried to attract players with loud sounds and easy introduction melodies.

35 See Collins, 2008, p. 12
36 Ibid.

“Sound had to be loud, and sound effects and percussion more prominent, in order to rise above the background noise of the arcade, attract players, and keep them interested.”[37]

Music in the arcades had to be instantly accessible, recognizable and give the player a familiar feeling, so he or she would come back to this specific game machine.

Due to the facts that sound couldn't be used while playing and that sound was only used as a functional feature, the music in the beep-games was not interactive. The sounds were primarily non-diegetic. However, players and developers were totally fascinated by the sounds and considered the simple beeps as “realistic”[38].

3.2 Understanding the possibilities: 1978 – 1981

Between 1977 and 1978, the video games industry experienced its first crash. Greedy for success and a pioneer reputation, the companies developed plenty of new hardware and forgot to develop software as well. Space Invaders (Taito, 1978) was the arcade game that brought the video games industry back, and that finally made people realize the importance of game music. The game “used sound in a functional way: the rhythmical bass-based soundtrack, which sped up with the rhythm of the game, was an integral part of the game experience.”[39]

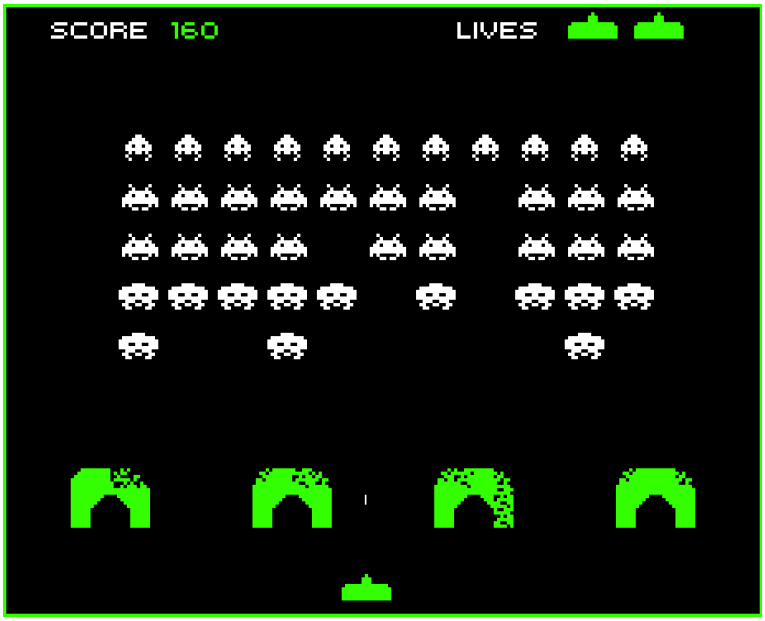

Figure 4: The original arcade game Space Invaders, 1978

37 Collins, 2008, p. 9
38 See Collins, 2008, p. 9
39 Malliet / de Meyer, 2005, 29 cited in Fritsch, 2012, p. 13, emphasis added

The game showed that music could be an integrated part of the gaming experience, and also that music could – and should – be dynamic. It also was the first game using continuous music instead of sound effects. Space Invaders was released on home console as well in 1980.

The next step forward regarding the music in the home console market was taken by the Intellivision (Mattel, 1979). The Intellivision was the first home console capable of a three-part harmony, due to the PSG it used.

In the following years, the fast industry released more successful arcade games with continuous music. Asteroids (Atari/Midway, 1979) used a simple two-note melody, Rally X (Namco/Midway, 1980) introduced continuous, sampled music using looping, Pac Man (Namco, 1980) was the first game to include cutscenes accompanied by music[40]. All those games were in the first generation of arcade games using Programmable Sound Generators (PSG).

The PSG is an external sound chip, that was integrated in the arcade machines and in home consoles as well. It was programmable, which means that the sound depended on the developer's input. The sound generator included oscillators, and the developer now could specify the sounds and tones. This led to a wider range of possible sounds and tones.[41]

The introduction of external sound chips improved the sound capabilities and qualities enormously. Common chips could play three simultaneous square-wave tones and white noise. So there were at least four channels of memory and tonal possibilities, only for the sound.

All those improvements needed digital bit signals to be processed and stored by the machine. To gain digital sound, the music had to be sampled and reduced to digital data, called bits. Data, of course, can't be heard. Therefore, the machines had to re-convert the bits into an analog audio signal in a waveform. To do that, they used so-called digital-to-analog converters (DAC).[42]

40 Cutscenes are intermissions in the game that link between several parts in which the player cannot influence the game, see Fritsch, 2012, p. 13
41 See Collins, 2008, p. 10
42 See Collins, 2008, p. 13f

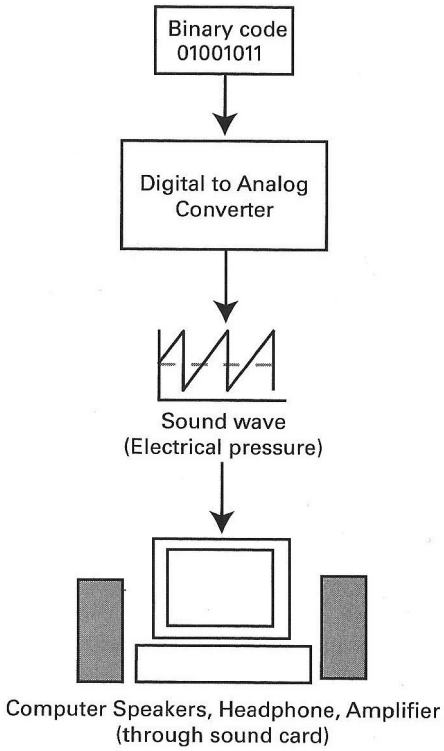

Figure 5: Digital-to-analog conversion

Digital-to-analog conversion still is used in today's technologies.

Even though the PSG made more memory and possibilities available for music, the developers still fought for space in order to create diversified music. Accordingly, sound developers started to use looping and random sequencing of their music.

One of the most impressive and pioneering games in this time was Frogger (Konami, 1981). The arcade game had eleven different gameplay songs in addition to an introduction theme and a game over song and, of course, sound effects. The levels in the game had a time limit, and every musical sequence was at least as long as this limit. The player had to guide a frog past various obstacles to a safe place. The musical sequences changed when the frog reached the place, when he died or when the time ran out. Thus, the music didn't need to loop and was, furthermore, dynamic.[43]

43 See Collins, 2008, p. 19f

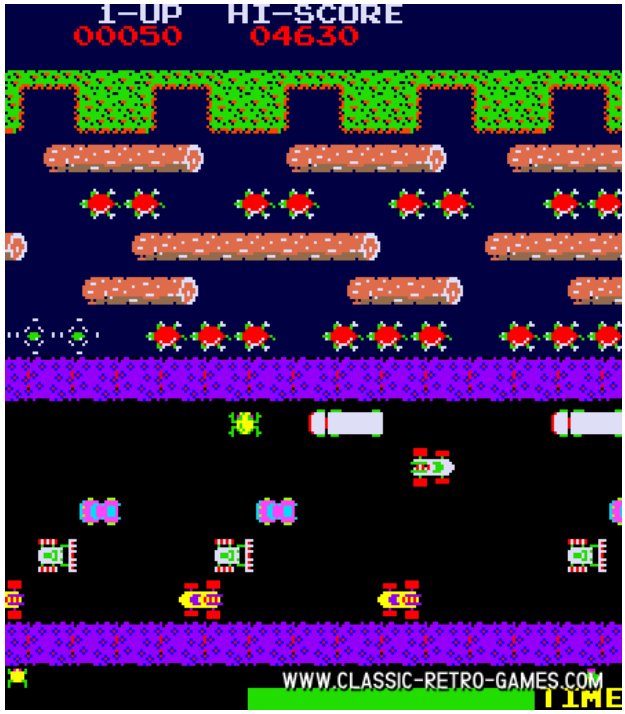

Figure 6: The original arcade game Frogger, 1981

Between 1978 and 1981, the video game industry finally understood the importance of music in video games. Developers realized that the sound can immerse the player into the game and improve a game's quality, and that sound is not only useful for attracting players in the arcade halls.

Therefore, music was no longer only used in the interface and for the “Game Over”, it also entered the game world. Due to the developments in sound storage and quality, it was now possible to play continuous, tonal background music while the game was in action. The possibilities were used and every game included sound effects and looping musical sequences. The music was recognizable and simple, long loops described areas, shorter loops raised the tension for key parts in the game. But music was still difficult to implement.

> “In the early days of video games, most composers of the music were in fact programmers working on other aspects of the game […]. Games were typically written in assembly language, making it difficult for many musicians to become involved in songwriting.”[44]

Therefore, and due to tight budgets and not finally defined licensing questions, games often used pre-composed music. Classical music, folk songs and some popular songs were typical, some games used licensed music.

44 Collins, 2008, p.114

At the end of this era, the game Frogger introduced the following era with the first step towards interactivity and originality. Frogger used non-diegetic adaptive music. The music was outside the game world and changed whenever a goal was reached. It also used original music.

3.3 Set the course: 1982 – 1990

Inspired by the last years, the video games industry produced several new home consoles, computers, the first handhelds and, of course, many video games in this defining era.

Similar to 1972, Atari pioneered with its home console 5200 (1982). It used the "POKEY"[45] audio processor using four channels with controlled pitch, volume and distortion. The sound was comparable to a virtual band. However, in the same year, the successful home computer Commodore 64 (C64, Commodore, 1982) entered the gaming industry. It was built as a home gaming computer and also marketed that way, which is why it is the most successful computer ever.[46] The C64 came with a Sound Interface Device (SID) chip that had three sound and one noise channel. Furthermore, it had an integrated synthesizer.

C64 games' music often was covered or pre-composed. Especially classical music was common, like in Zak McKraken (LucasArts, 1988).

The arcade game Dig Dug (Namco, 1982) introduced the next level of interactivity. The music and sound effects depended on the player's direct input and changed when the player executed an action. At the same time, the game Journey's Escape (Atari, 1982) made the popular music industry enter the video game world. In the game, the musicians of the band "Journey" had to fight their way to a safe place. Their instruments were used as weapons and their music was the background music for the game.[47]

The game Moondust (Creative Software, 1983) showed an early example of a game using a dynamic ambient score. It is a generative music game in which the player has to score as many points as possible in order to make the music sound good.

After this quite promising start in the 1980s, a second crash hit the video games industry. In contrast to the first one, this time the industry produced too many and too similar games instead of producing too much hardware.

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45 Potentiometer and Keyboard Integrated Circuit. See Marks, 2012, p. 3 and Fritsch, 2012 p. 13
46 See Collins, 2008, p. 30
47 See Collins, 2008, p. 111f

The company that rescued the industry – until today– was Japanese and came with a plumber. The Nintendo Entertainment System (NES, Famicom in Japan, Nintendo, 1985) was a home console. It used a custom made PSG with five channels of monophonic sound, capable of sound effects and music. Together with the console, Nintendo released the game Super Mario Bros, which was going to be a long-lasting, huge success. The game was the first game with continuous background music written by an actual composer. Regarding video game scores, Japan was pioneering, which reawakened the competitive industry.[48]

Figure 7: The original NES game Super Mario Bros.

In the following years, Nintendo released plenty of successful games for the NES: Metroid (1986) is remembered for an unusual use of the sound channels and The Legend of Zelda (1986) is known as one of the games with the most beautiful scores ever. Nintendo games usually used one sound channel for percussion, and the other ones for music and sound effects. Nintendo used various loops for their music's structure, their length was genre-dependent. Platform adventures, for example, looped longer due to the fact that a player needed more time to complete a level. Furthermore, loops were used more than once within a game, due to the still not too big memory. But even though loops were recycled, Nintendo implemented adaptive elements and changes in the music.[49]

48 See Fritsch, 2012, p. 18
49 See Collins, 2008, p. 25f

Besides Nintendo, other companies, of course, also filled the market with products.

The next home console and company introduced to the market was the Master System (Sega, 1985)[50], an 8-bit console that relied on popular arcade games. It could not compete with the NES, but it brought attention to Sega. It had monophonic sound generators that had a tonal range of four octaves.

In the personal computer market, the Apple II was followed by the PCjr (IBM, 1984). It used a PSG from the arcade machines and had enhanced graphics (compared to its predecessor IBM PC). According to Collins “the enhanced graphics and sound illustrated the importance of video games to the home computer market.”[51] Therefore, several games were developed for the IBM PCjr, using all available sound and graphic possibilities, like King's Quest (Sierra On-Line, 1984).

Besides IBM, the Apple II evolved, too, and better models were released, using classical arcade sound chips. Another home computer competitor, the Amiga (Commodore, 1985) used the sound chip Paula. It was capable of four channel 8-bit stereo sound.[52] Each channel had its own volume control and it could produce sounds with a tonal range of nine octaves. Sound also could be synthesized, stored and played back. The Amiga, furthermore, was the first home computer that used Digital Signal Processing (DSP) for sampling.

DSP allows to process a sound signal. Common effects made with DSP for video games were echoes, time stretching, equalization, filtering and compression.[53]

The Amiga introduced the musical data format MOD as well. The module format is a file standard for digital music. It included patterns and instruments in the same file.[54] To save a file as MOD, the composer worked with a so-called “tracker program”. “A tracker program would store data on the notes, volume setting, effects, and instrument (like MIDI), but could also include digital samples of the instruments in the actual file.”[55]

MODs sounded comparatively realistic (compared to other digital audio formats) and due to the tracker programs, it was good to handle for non-musicians.[56]

Besides those gaming personal computers (PCs), other computer developers influenced the video games industry, too, especially by releasing new external sound cards.

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50 See Frank, c2003-2012
51 Collins, 2008, p. 29
52 Stereo sound is sound recorded with more than one microphone, using separate channels in order to gain a spatial sound. See Collins, c2015
53 See Collins, 2008, p. 46
54 See Fileformat, undated
55 Collins, 2008, p. 58
56 See Collins, 2008, p. 58f

“Recognizing that gamers and musicians wanted better sound from their PCs, add-on third-party FM soundcards began to develop in the mid-1980s.”[57] The first popular sound card for home computers was the AdLib Multimedia (1986). It was based on a nine channel Frequency Modulation (FM) chip.

Frequency Modulation was a technology developed in the late 1960s. The adaptation for the video games industry, called FM synthesis, got popular through the home computer industry. FM synthesis allowed music developers to create any sound or tone using a modulation sound wave and oscillators. FM synthesis also was used in arcade games of the late 1970s. A machine could also use several FM chips. FM was especially used in order to make sounds more realistic.[58]

Several other sound cards also found their way into the industry, always using FM or PSG chips with several sound channels.

Of course, not just machines, but also games were produced in the 1980s. Dragon Quest (Chunsoft et.al.,1986) symbolized the next step towards more attention to music. Its score was recorded with a live orchestra and sold separately from the game.

Nevertheless, “the music industry had not yet discovered the potentials of the medium as a form of promotion and sales.”[59] In Japan, the Dragon Quest score was even performed live as a concert series, once again Japan pioneered. They recognized the power of video game music and were, with Koji Kondo from Nintendo, the first to employ composers for their video games and to use the music as a marketing instrument.

57 Collins, 2008, p. 48
58 See Collins, 2008, p. 10, 38
59 Collins, 2008, p. 33

Figure 8: Poster of the first video games live concert in Tokyo, 20.08.1987

The Final Fantasy series were introduced in 1987 (Square). The role-playing game has an interesting score. It is, as usual in Japan, an original score. What is remarkable is its combination of eastern and western styles in instrumental music.

Besides the role-playing game Final Fantasy, the rhythm-action games also slowly found their way into the mainstream games market and into the homes of players.

> "Rhythm-action games are video games in which the player must respond in some way to the rhythm or melody being presented, either through repeating the same melody or rhythm by pressing buttons (with hands or feet), or kinetically responding in some other way to the rhythm, often using specially designed controllers."[60]

60 Collins, 2008, p. 74

Dance Aerobics (Human Entertainment, 1987) was delivered with the “Power Pad”, a floor-mat controller with pressure sensors in it. The player had to step onto the right space on the mat to play.

The adventure game Maniac Mansion (LucasArts, 1987) introduced the SCUMM engine. It was a software engine for building adventure games, and it was going to work together with iMuse (see following chapter).

In the late 1980s, the first 16-bit consoles were developed little by little. The first one was the PC Engine (also known as TurboGrafx16, NEC, 1987). It had 16-bit graphics and six channels of stereo sound.

The MegaDrive or Genesis (Sega, 1988) used a classical PSG chip to handle sound effects and music in addition to an FM synthesis chip with six channels of digitalized stereo sound and a Pulse Code Modulation (PCM) 8-bit sample channel. It was very successful, due to the fact that Sega owned many popular arcade games, which could be re-released on the home console.

Sega used the popular sound of the arcades for their games. For new games, they introduced music and instrumentation inspired by progressive rock. They also used modal harmony and chromaticism. Furthermore, Sega discovered the concept of cross-marketing, releasing games that collaborated with celebrities, like Michael Jackson's Moonwalker (Sega, 1990).

However, in this competitive industry, the answer to the Genesis didn't take too long. The Super Famicom or Super NES (SNES, Nintendo, 1990) was superior in sound and graphics. The sound module of the SNES had an 8-bit co-processor with an attached DSP. The DSP supported eight channels of programmable stereo sound, realized through wavetable synthesis.

“Wavetable synthesis used preset digital samples of instruments, usually combined with basic waveforms of analog synths.”[61]

Therefore, the sound was more realistic than with FM synthesis alone.

The SNES secured its success with movie tie-ins and the use of licensed popular music. Its games used music from the genres dance, hip-hop, hard rock and also some classical music. Furthermore, Nintendo employed musicians to compose original video game scores.

61 Collins, 2008, p. 46

Both consoles, the Genesis and the SNES, used a similar music structure. Chords were simulated by adding overtones, the looping structure was typical.

“Boss music typically had at most three short sections which repeated, gameplay levels had longer cues, and genres still maintained the same influence over the length of sections and songs.”[62]

The consoles also used their sound channels in a similar way, using some for several instruments, one for sound effects, percussion and noise and one for voices.[63]

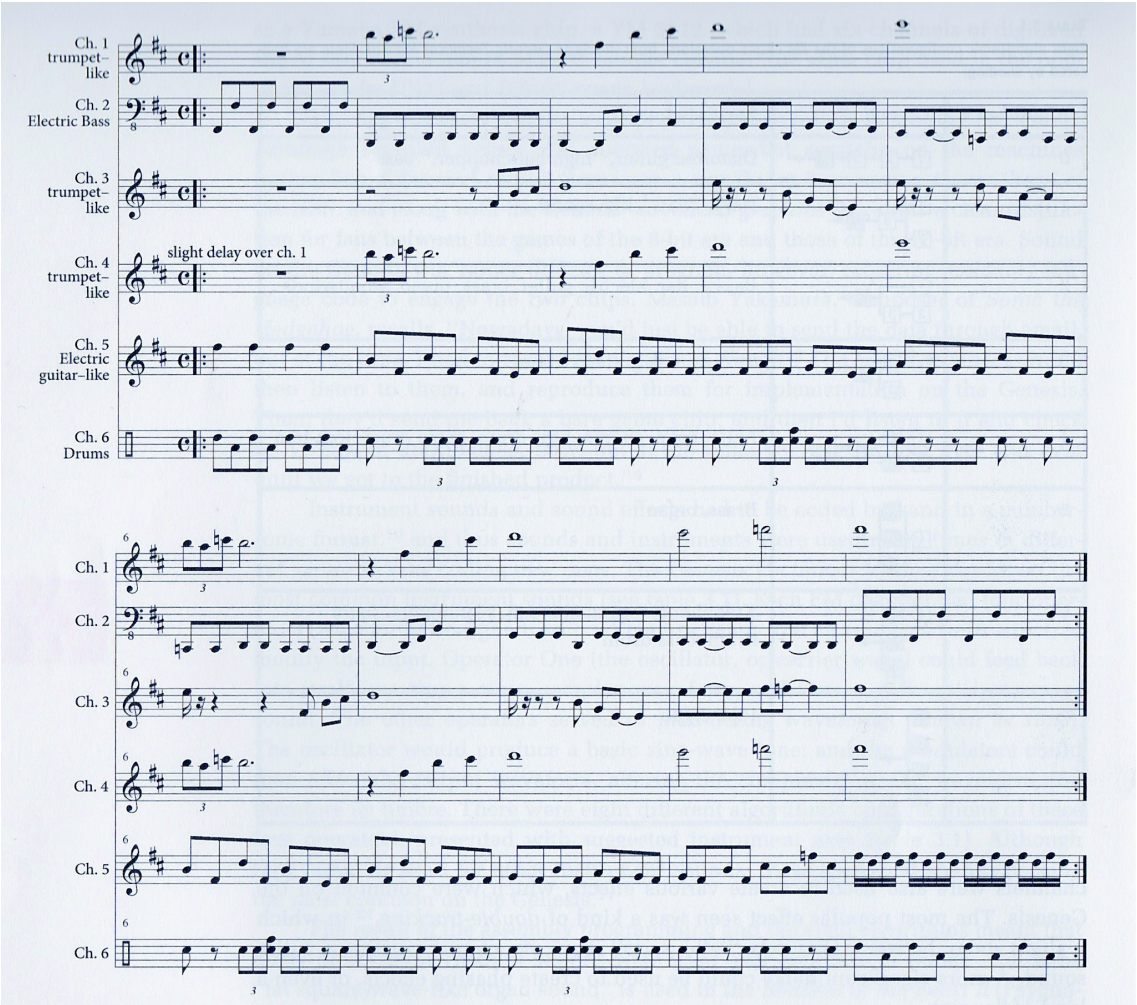

Figure 9: Boss music from Sonic the Hedgehog (Sega, 1991), showing very typical use of the Genesis chip's channels

The boss theme for Sonic the Hedgehog (Sega, 1991) shows a typical use of the sound channels. One channel is used for percussion, the other five channels are for

62 Collins, 2008, p. 47
63 Ibid.

the instruments. Due to limited instrumentation possibilities, often a bass line was used and covered with two or three additional instruments.

Besides home consoles and home computers, a novel gaming platform entered the gaming market. Handhelds made the video games industry visible in public, as they could be played anywhere at any time. They were “smaller, battery-powered portable consoles with built-in screens”[64]. Nintendo introduced handhelds in 1980, calling them Game & Watch. Before that, some games like Touch Me were also released as handheld. In the 1980s, some other companies like Atari and Sega also released their home consoles in a handheld version. However, real popularity of handhelds came in 1989 with the Nintendo Game Boy.

It was the “first true handheld game computer”[65] and it got real popularity with the game Tetris.

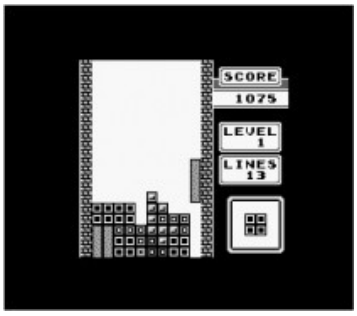

Figure 10: Tetris on the Nintendo Game Boy

Tetris had three background themes or could be played with sound effects only. You can see the beginning of the most popular theme “Theme A” in Figure 2.

The Game Boy had a stereo sound PSG with three sound channels and one noise channel, that was capable of 4-bit noise. It included a simple envelope generator.[66]

Inspired by the success of Tetris, Nintendo also brought their NES stars Super Mario and The Legend of Zelda to the Game Boy in the 1990s.

However, the most significant advance for sound in the 1980s wasn't a game or a console. It was the Musical Instrument Digital Interface (MIDI) protocol. MIDI was introduced in 1983, games began to use it in the mid-1980s.

64 Collins, 2008, p. 75
65 Malliet / de Meyer, 2005, 36 cited in Fritsch, 2012, p. 20
66 An envelope generator controls the rise and fall of a tone's volume, see Various, undated

> "MIDI is a communication protocol where music is represented as digital data 'event messages' such as the pitch and intensity of musical notes to play, control signals for parameters such as volume, vibrato and panning, cues and clock signals to set the tempo."[67]

The implementation of MIDI in the games industry made it possible for actual musicians and composers to create music on their keyboard or a synthesizer, instead of programming it. Using the words of Fritsch: "this industry-standard protocol defined in 1982 allowed musical devices such as keyboard controllers, computers, and other electronic equipment to be compatible and synchronize with each other."[68]

MIDI didn't need much memory, but it was limited to 128 instruments. Nevertheless, the musician's flexibility grew significantly, even though the various hardware still made the music sound different.

Between 1982 and 1990, the video games industry made a huge step towards being a serious entertainment industry. Its graphics and its diversity grew exponentially, even though the industry had a crash. The music explored new possibilities, due to huge improvements in the technology: "audio processors continued to improve, adapting synthesizer chips, 16-bit processors, more voices, more memory, better compression and decompression algorithms, and even internal effects processors."[69]

Music is not technology. However, in the video games and general digital media industry, advances in technology are directly related to the music, as they open up more possibilities. The musical evolution, insofar, could only happen due to the implementation of technological advances.

But those technological developments could only take place because the people wanted them. Both developers and players realized the strength and importance of game audio. They pushed the industry forward with new demands and the wish to mark a new developing industry as pioneers. In fact, the companies were more interested in being competitive than developing new, ongoing technology. But nevertheless, "the 16-bit era marked a time when game audio was no longer viewed as an afterthought, but was, rather, the turning point of many interesting developments in the history of games."[70]

The implementation of external sound chips, using the FM synthesis, DSP or the MIDI protocol gave the composers huge possibilities to create music with more quality and

67 Guerraz / Lemordant, 2013, p. 56
68 Fritsch, 2012, p. 21f
69 Marks, 2012, p. 3
70 Collins, 2008, p. 59

creativity – independent on the platform. The introduction of MIDI and MOD also invited actual musicians and composers to the video games industry.

“The development of the General MIDI standard and advancements in sound hardware enabled improvements in sound quality and polyphony, as well as increased memory, allowing for more music and longer songs.”[71]

Therefore, video games started to implement continuous music in addition to sound effects in every game. The musical sequences were looped or randomly programmed, due to the still limited memory possibilities. As before, levels used long loops, tension scenes used shorter loops. The musical genres depended on the game genre and the company. As mentioned earlier, developers like Nintendo and Sega typically used the same kind of music for all their games.

The use of pre-composed popular or classical music grew significantly. The game developers recognized the positive effects of cross-marketing. Using licensed music was critical, as licensing got more difficult. “The majority of music in computer games, is pre-composed and serves a role similar to that of film music, constituting a crucial component.”[72]

Nevertheless, some companies like Nintendo also valued original music – successfully. As the industry was going to see, originality is popular.

As the music was now stored on separate sound cards, it could also be used more often. The music underscored the whole game. Interface, Game Over sequence, sound effects, background music and sometimes cut-scenes were all supported with music. The composers used leitmotifs and the mood technique to immerse the player into the game and into the game world. To gain the most possible immersion, they also tried to include interactivity into the music, using Mickey Mousing and changing scores..

In all games, the interface music, the cut scenes and the game over sound were non-dynamic and non-diegetic. Background music and sound effects were partly diegetic and partly non-diegetic, dependent on the genre. In adventure games like Super Mario Bros., they were usually non-diegetic adaptive, in shooters, they were diegetic interactive or diegetic adaptive. In rhythm-action games, the music was interactive, while the distinction between diegetic and non-diegetic is impossible due to the lack of a clearly defined game world.

71 Collins, 2008, p. 61
72 Grimshaw / Tan / Lipscomb, 2013, p. 653

All music of this era was lacking smooth transitions. The music usually hard cut between the sequences, only some games used rapid fade-outs. Looping and random sequencing still were common practice.[73]

As mentioned earlier, the players and developers realized the importance of music. For players, the realistic sounds made with FM synthesis, DSP and MIDI symbolized immersion into the video game. Furthermore, games used catchy music, like Tetris, and popular music, to make games more rememberable and to market them.

All in all, the 1980s marked the most important decade for the video games industry due to developments in every direction. But, as will be shown, the 1990s also brought some incredibly important improvements to finally make the music free.

3.4 Last developments: 1990 – 1999

Inspired by the last decade, the games industry continued to evolve.

In the 1990s, the video games industry discovered a new musical standard, which would stay until today. The CD-ROM freed the musicians from all limitations regarding the instrumentation. Therefore, they could now use all live-instruments and record them, together with vocals, sound effects and dialogues. Furthermore, the composers could now imagine how their music would sound, as all CD-ROM devices sounded similar. With the rise of the CD-ROM, more popular bands got interested in video games, as composing became easier for them. They could now work with a standard they already knew. Thanks to this, the usage of licensed music, as well as the general interest in composing for the video games industry, increased. The only limitation was the available space of 72 minutes for the whole game. So the music still had to fight for space.[74]

The usage of pre-recorded licensed music improved the sound quality significantly, as the composers only needed to handle the tracks. Besides the memory problem, looping was problematic as the CD-ROM had to jump back to the beginning when it was finished, which caused a sound gap.[75]

The memory problem was diminished through the introduction of audio compression formats like MP3 (released in 1993).

73 See Fritsch, 2012, p. 27
74 See Collins, 2008, p. 63
75 See Fritsch, 2012, p. 245

Together with the game Monkey Island 2: Lechuck's Revenge (LucasArts, 1991), another advance for games' audio came along. The Interactive Music Streaming Engine (iMuse). It was made especially for PC adventure games. The engine kind of replaced Mickey Mousing in creating interactivity in video games and it was a really original approach.

According to Strank, it was the most important advance for interactivity: “the simple cause-and-effect sound design of early video games might have had an interactive component, but it was not until the advent of iMuse in the early 1990s that the phenomenon of interactivity fully entered the world of such music.”[76]

It was designed to make it easier to create dynamic music, especially for composers that worked with MIDI. iMuse “was a database containing musical sequences. These musical sequences contained 'decision points', or markers, within the tracks. These decision points marked places where changes or branches in the performance could occur based on a condition in the game in real time.”[77]

Therefore, the composers could implement their music and test it with adding markers to the musical events and to in game events.

Besides musical advances, another significant new technology evolved in the 1990s. The world wide web made it possible to host a game on a server in the internet, so only new software and no new hardware was required. Furthermore, players could play together in big or small groups and communicate while not being in the same room.

With more possibilities in the creation of music and technology, new genres evolved, too.

The rise of the internet popularized casual games like Sudoku, pool billiard and Mahjong, as they now also could be programmed and implemented into other internet based applications like messaging services, allowing users of these to play short games against each other. However, some genres like role-playing games and FPS gained new possibilities as well, due to the internet. Players could now play together while not being together and they also could play with random players from the whole world. Accordingly, the developers reacted by developing “massive multiplayer online” (MMO) games where countless players could play independently or together at the same time in the same game world.

76 Strank, 2012, p. 81
77 Collins, 2008, p. 52

For the composers and musicians, the rise of MMOs brought new challenges. The gameplay time in MMO games is not limited. Thus, the composer has to compose hours of music or music that doesn't lose the tension. The first MMORPG released in the 1990s was Neverwinter Nights (Stormfront Studios, 1991).

Doom (Id-software, 1993) was a science-fiction FPS game. It included leitmotifs for various types of enemies and the sound effects therefore were a key part of the game. They gave the player information about enemies so he or she could react immediately. The sound effects “have also elevated the role of sound design and clearly reinforce the idea that playing a game with the sound left switched on is often critical to success.”[78]

However, the music needed to become spatial in order to be helpful. This was only possible because of the ongoing evolution of the so-called surround sound: “surround sound gives the listener the perception that the sounds are emanating from a three-dimensional space.”[79]

The first games to use surround sound were racing and simulation games in the arcades. Its evolution in the 1990s increased the use on new genres and platforms, as mentioned earlier. It was implemented into the programming, but to perfect the technology (that had to fit exactly to the graphics), new software was required.[80]

While it was developed, an interesting new genre entered the gaming industry and opened the market for more players.[81] The computer puzzle game Myst (Cyan, 1993) showed a new audience the beauty of gaming, especially in its soundtrack. The score worked with silence, minimal ambient music and sound effects.

78 Collins, 2008, p. 66
79 Collins, 2008, p. 64
80 Ibid.
81 See Collins, 2008, p. 66

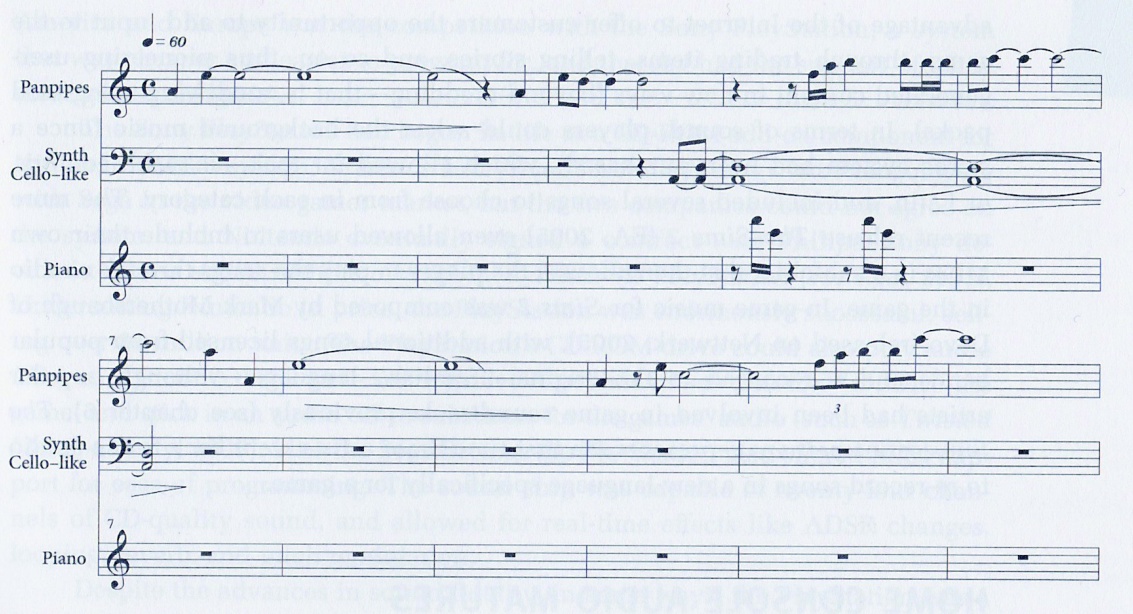

Figure 11: Myst, "Above Stoneship (Telescope Theme)"

The musical sequences are minimalistic in instrumentation and melody, they shouldn't distract the players.[82] The musical theme immerses the player into a distant game world, where he can concentrate on the puzzles.

In 1993, 32-bit home consoles entered the market. The Jaguar (Atari) and the FZ-1 3DO (Panasonic) both came with passable graphics and CD-ROM audio quality, but both didn't succeed, partly because of the following 32-bit consoles.

The Saturn (Sega, 1994) also was CD-ROM based and had two processors (out of eight) dedicated to music. The implemented sound processor had a 16-bit DAC in addition to a 32-channel PCM sound generator. The sound corresponded to CD quality. Its competitor, the PlayStation (Sony, 1994) also used a CD-ROM drive, that was capable of playing audio CDs as well. Its sound chip was capable of twenty-four channels of CD quality sound. Furthermore, it allowed real-time effects like looping and the player could also listen to his or her own music during the game. The PlayStation is known for its huge success.[83]

CD quality usually meant “Redbook” quality. Redbook is a standard for a CD.

“The Red Book standard specifies that a compact disc can have up to 99 tracks of data, with each track containing a single audio selection.”[84]

82 See Collins, 2008, p. 67
83 See Collins, 2008, p. 68f
84 Sound on sound, 1998

The game Rise of the Robots (Time Warner Interactive, 1994) signed an example for a game containing popular music. The soundtrack combined electronic music with music by the popular musician Brian May.[85] Another example was Wipeout (1995). It featured exclusive tracks by popular artists including Daft Punk and The Chemical Brothers.[86]

In 1995, the home computers got a new standard. The system software Windows 95 (Microsoft, 1995) came along with “DirectX”, a package of application programming interfaces (APIs). It made a communication between the software and hardware easier. Therefore, the sound mixing and output control improved. Furthermore, DirectX included an interface called “DirectMusic”.

“DirectMusic opened up MIDI to the possibility of higher-fidelity wavetable synthesis and sampling, while at the same time it allowed MIDI to have more extensible controls.”[87]

Accordingly, the music was more predictable, as it didn't depend on the sound card anymore.

DirectX allowed surround sound to improve finally, as it improves the communication between soft- and hardware significantly. The next step in the development, thus, was the 3D sound card. It first entered the market in 1997.

The next successful console after the PlayStation was the Nintendo 64 (N64, Nintendo, 1996). As the name suggests, it was the first 64-bit console. From now on, the bits of a game were no longer revolutionary, as the technology developed so fast. The N64 audio supported 16-bit CD quality, some games even supported surround sound. DSP effects could be implemented in the machine's CPU or into the game in real-time.[88]

The music on the N64 relied, unlike other consoles in the 1990s, on the General-MIDI. The composers used programs like MusyX (comparable to iMuse) to adapt the sound.

The program “MusyX offered wavetable synthesis with samples the composer could input, in a MOD-like format.”[89] Like iMuse, the music could be implemented using markers to make interactive and adaptive sounds possible. Furthermore, multiple sequences could be played back at the same time, which allowed the use of new effects like cross-fading.[90]

85 See Collins, 2008, p. 113
86 See Rauscher, 2012, p. 93
87 Collins, 2008, p. 65
88 See Collins, 2008,p. 69f
89 Collins, 2008, p. 70
90 Collins, 2008, p. 70

The software toy Simtunes (Maxis, 1996) was a game about creating music. The player painted colors, that each represented a musical note. Insofar, he could design musical pictures.

The game Diablo (Blizzard North et al., 1996) is popular for its music as well. The guitar intro in the popular “Tristram” theme is known for its strings. It was not just made with the synthesizer, unlike most of the soundtrack. Therefore, it fascinated with its realness.[91]

PaRappa The Rapper (SCEI, 1996) was the next nameable rhythm-action game on the market. It was released for the PlayStation. The players had to re-create a song with the controller that was shown by the rapper dog PaRappa.

Quake (id Software et al., 1996) was one of the first online MMO FPS, that accordingly required hours of music and sound effects. The music was produced in cooperation with the frontman of the popular band Nine Inch Nails. The band's logo also appeared in the game to show the relationship.

Beatmania (Konami, 1997) was a DJ-simulation game. Together with all the other rhythm-action and music games released in the following years (and Dig Dug, released in 1982), it unleashed a boom for musical games.

With The Legend of Zelda: Ocarina of Time (Nintendo, 1998), an exemplary use of dynamic music, and the usage of music as part of the game (like it is in rhythm-action games), was released.

Figure 12: The Legend of Zelda: Ocarina of time, Link playing the ocarina.

91 See Fritsch, 2012, p. 25f

The main character Link had a flute-like instrument called ocarina, which he had to use to open portals or summon allies. Therefore, the player had to remember various melodies. The game also shows a great use of dynamic audio components, in implementing adaptive-diegetic audio. It is also popular for its great music.[92]

Few companies still released arcade games because it was a dying market. But the game Dance Dance Revolution (Konami, 1998) inspired eventual rhythm-action games. The game brought dancing into the arcade halls using sensor equipped dance mats.

The 1990s also brought some new handhelds into the market, but due to the success of the Nintendo Game Boy and its follow-ups they didn't succeed. The Game Boy itself released two follow-ups: in 1996 the Game Boy Pocket and in 1998 the Game Boy Color. Both came along with better graphics, but the sound quality was unchanged. However, in the late 1990s, the mobile phone became a novel platform for video games. The music for those games had the exact same problems as those of early arcade eras: limited memory and bad sound quality, therefore only casual games were successful, like Snake (1997). But the music also should remain silent, as the games often were played in public to kill time, and the players didn't want music.

The Dreamcast (Sega, 1998) was the last home console released before 2000, and the last ever released by Sega. The two sound processors had their own memory, so the sound wasn't affected by the game. Furthermore, the console supported uncompressed samples, so the audio could be played back with more fidelity. Due to the low sales and the release of more successful competitors, the console was discontinued in 2002.[93]

Around 1998, the first games with a fully live-recorded original orchestra score were released. Lost World (Interactive, 1997) and Heart of Darkness (Amazing Studio, 1998) are both mentioned as first games, even though some games earlier included parts of live-recorded music. Who was first doesn't matter. It only matters that both showed the industry a magnificent alternative to licensed pre-composed music and MIDI, that was going to be implemented in many games.

Nevertheless, licensed music was still used, like hip-hop in Tony Hawk's Pro Skater (Neversoft, 1999) and electronic music in Silent Hill (1999). Space Channel 5 (United game artists et al., 1999), a music video game, also used popular music. The player

92 Fritsch, 2012, p. 26f
93 See Collins, 2008, p. 71

had to repeat dance sequences in time to a rhythm. The cooperation with movies and celebrities still was popular as well, especially in order to market the game. “Music licensing in particular is becoming an increasingly essential element of a game's marketing strategy, as it helps to reduce some of the costs and risks of bringing a game to market.”[94]

Popular music especially was used in rhythm-action games and in some musical theme games, and in movie tie-ins. Some music even was re-recorded for the games. The cooperation with popular music also increasingly symbolized a marketing cooperation.

The 1990s brought the last big innovations to the video game audio world. Of course, technology still evolved and many more games, consoles and PCs were going to enter the industry, but with the CD-ROM and the implementation of DirectX and iMuse, the video games music got everything it needed to become serious and get free.

> “The introduction of better storage devices such as CD-Roms and DVDs enabled the recording of complete orchestral scores for video games, while systems like the iMuse […] provided structural devices for organizing the tracks in a seamless interactive way.”[95]

The introduction of DirectX and the rise of the internet changed the market. Home consoles were still important, but the 1990s particularly brought significant changes in the home computer world. That lead to more games for the PC. At the latest by now, the arcades were replaced by handhelds and mobile phones.

With the evolution of technologies like iMuse and surround sound the implementation of dynamic audio finally became possible and popular.

“Dynamic music is becoming more of a requirement for games as production values increase and players tire of the typical looping playback model of older games music.”[96]

Insofar, the role of music grew significantly for players and developers. Music, in some games, was a key element of the performance. Games like The Legend of Zelda or PaRappa the Rapper had musical challenges, FPS games made music a necessary feature with the usage of surround sound. Rhythm-action games are based on music and musical interactivity. Furthermore, more original and creative scores enhanced the gameplay and the immersion. The music got important and self-evident, it even was sold separately from the video games. Video game music started to become autonomous.

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94 Collins, 2008, p. 108
95 Rauscher, 2012, p. 104
96 Collins, 2008, p. 139

For composers, it was now possible to actually compose due to technical developments. Accordingly, the musical quality and diversity grew. Games used popular music of nearly every genre, dependent on the game genre. More games used original music, and a complete live-recorded score was now possible and respected. In fact, the live-recorded score should inspire the next era significantly. The musical structures also became more varying. Looping didn't satisfy the demands of players and developers any more. Therefore, the games included more different musical sequences and due to more possible instruments, more instrumentations and genres. The musical structure was genre-dependent. Nevertheless, Mickey Mousing, moody technique and leitmotifs were still used.

Music, like in the 1980s, was always used in the game. Continuous background music immersed the player in every game, in-game sound effects finalized the atmospheres. The music was functional and aesthetic, it communicated with the player to inform him about in-game actions, enemies and other events like level ups. Furthermore, it was used to immerse the player into the game, as film music does. Music was seen as a relevant part of the game's enjoyment. The music also was used to sell the game and its epic or casual character often stayed in the players' minds.

The consoles spared more memory for the audio and the sound chips improved. Thus, the developers used more instruments, more harmonies, multichannel sound and more effects. The music became more realistic and was better comparable to music from the music industry. Especially the introduction of the CD-ROM with its 16-bit stereo sound helped set new musical standards. The introduction of the CD-ROM furthermore made it easier to sell soundtracks separately and it invited musicians to the gaming industry.

Due to the introduction of 3D sound and iMuse, the music could be implemented in the game in several ways. Accordingly, the use of diegetic and dynamic music grew significantly. Background music developed in being more adaptive non-diegetic. Sound effects, like in the 1980s, were partly diegetic and non-diegetic. Furthermore, they became more adaptive. The use of non-dynamic music decreased. The use of diegetic music, however, increased in general.

The last important technologies for the game music were developed in the 1990s. The musicians now had nearly unlimited possibilities and could use their creativity. Together with the advances in graphics and machine technologies, video games formed a real entertainment media ready to be explored in its fully pride.

3.5 Let creativity take its course: 2000 – today

In the 1990s, the technology was developed so far that questions for audio quality and memory nearly disappeared. Of course, the competitive and motivated video games industry didn't stop there. Finally established as a real entertainment industry, the next fifteen years should bring a plethora of new games, consoles and technology.

The PlayStation 2 (Sony, 2000) came along with a DVD-drive and offered add-ons for a modem and hard drive. It was the first step for home consoles towards becoming a “home entertainment center”. All its games were stored on DVDs with several gigabytes of memory, it supported the multichannel 3D sound standards and had 48 MIDI channels in addition to 16-bit CD audio.[97]

The Sims (Maxis, 2000), one of the most popular simulation games ever, allowed the player to select his or her favorite background music. Its follow ups and add-ons continue the personalization, allowing to integrate the personal music and allowing networking via the internet (where players can listen to music as well).

The Game Cube (Nintendo, 2001) came along with sound qualities comparable to the PlayStation 2, but it didn't use a DVD-drive in order to prevent piracy.

The Xbox (Microsoft, 2001) was a really powerful home console. It had a powerful processor and eight gigabytes of hard drive space for graphics, sound and saved games. It was a home entertainment system containing the possibilities to play games, watch movies and listen to audio CDs. To guarantee a good audio quality, Microsoft developed its own audio processor called “SoundStorm”. It promised “movielike” sound with a 64 voice audio processor, 64 MB unified memory and 200 MHz bandwidth to the CPU. It also supported DirectX and had an online add-on called Xbox Live, in which the player could download new content for games.[98]

> “Due to the powerful hardware, composers now had almost total compositional freedom and decisions regarding music were linked rather to aesthetic and economic considerations as well as to questions of software […] than to technical restrictions caused by insufficient hardware.”[99]

Some musicians and companies relied on their typical musical style, but the musical possibilities also got explored in some games.

97 See Collins, 2008, p. 71
98 See Fritsch, 2012, p. 30 and Collins, 2008, 73
99 Fritsch, 2012, p. 30

The abstract rail-shooter computer game Rez (United game artists et al., 2001) used music in an unusual way. It worked with sound effects that were replaced by electronic music and had an optional Trance-Vibrator add-on.[100]

Grand Theft Auto 3 (GTA, 2001) included radio stations, that the player could listen to and change. The radio stations include music from different genres, like real radios do. Therefore, it had diegetic interactive music, which is special because diegetic interactive audio was typically limited to sound effects.

In the first decade of the new millennium a boom for rhythm-action games came along, especially because they included popular music and they could be played in groups. They were usually delivered with special controllers. Donkey Konga (Namco, 2003) came along with bongos, SingStar (London Studio, 2004) included a USB-microphone and Guitar Hero (Harmonix Music Systems, 2005) was delivered with a guitar controller, with which the player had to complete a popular song while pushing the right buttons. Donkey Konga and Guitar Hero both received an award for “Innovation” on the Game Developer's Conference.[101] The Guitar Hero series was expanded to Rock Band (Harmonix et al., 2007) due to the huge success of the format. Rock Band included a USB-microphone and drums in addition to the guitar controller.

Figure 13: The PlayStation game SingStar with its USB-microphones

100 See Ibid.
101 See Fritsch, 2012, p. 31

Besides those games, many other rhythm-action and party games were developed, not just for home consoles.

The game Halo 2 (Sumthing Else Music, 2004) is an example for games with separately sold original soundtracks. It includes original in-game tracks by game composers and remixes by popular artists.[102]

World of Warcraft (WoW, Blizzard Entertainment, 2004) is one of the most popular MMORPGs ever released. As is typical for online games, it has a large epic score. It is available separately and was recorded with orchestra and choir.

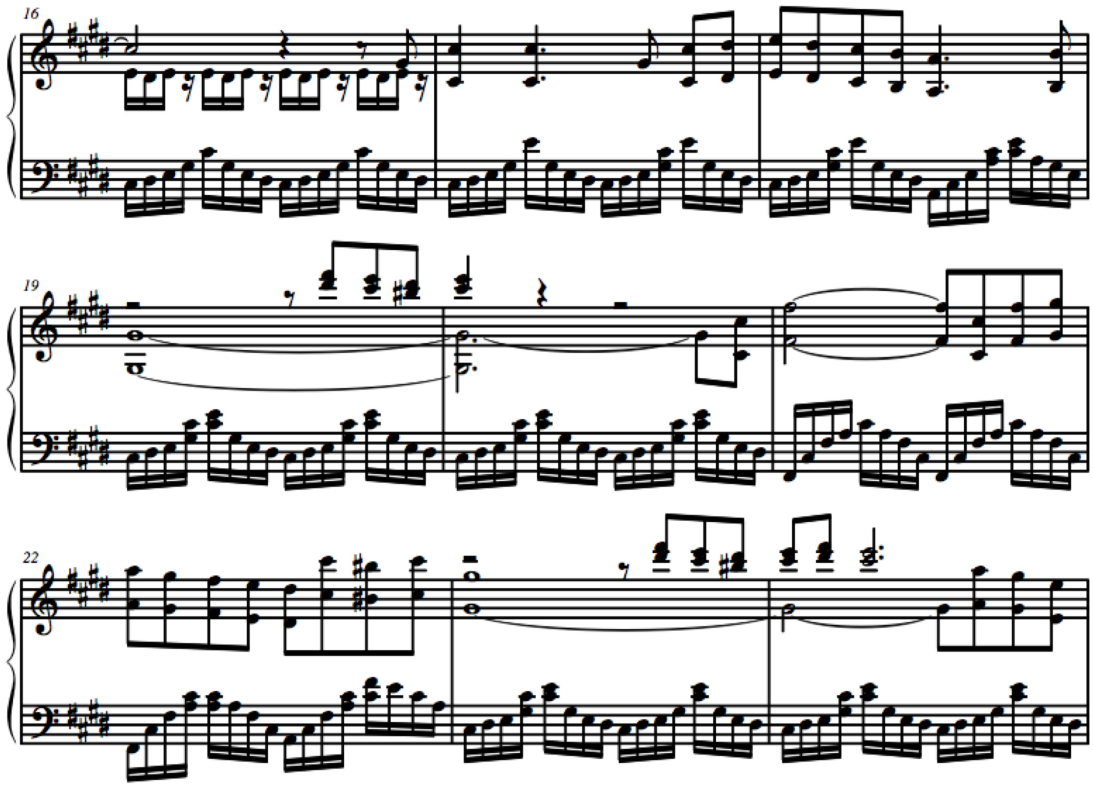

Figure 14: Part of the "Song for Elune" of the World of Warcraft score. Piano Arrangement by Gori Fater.

In the original score, this part is played by strings, and the song also contains vocal parts. The piano version hints at the power and complexity of the music. The rest of the score was also recorded with an orchestra in various instrumentations. The entire score was composed by a whole team of composers.

102 See Collins, 2008, p. 114

Many other MMORPGs or role-playing games also use orchestral epic scores, like they appear in movies. It seems to be the fitting musical genre to prepare the players for their battles or journeys, like in the Lord of the Rings series, and build an appropriate game world.

The Nintendo DS (Nintendo, 2004) and the PlayStation Portable (PSP, Sony, 2004) were the next successful handhelds after the Game Boy. The handhelds, like home consoles, developed to full multimedia devices, capable of playing movies and listening to music. The PSP has 3D multichannel sound and integrated stereo speakers, the Nintendo DS is like an instrument, having a MIDI, tracker and sampling software. It has virtual sound stereo speakers, a built-in microphone, sixteen hardware sound channels and two built-in samplers. The consoles adapted the successful genres and several successful games.

“A new dimension in mobile gaming was also opened with the rise of the so-called smartphones and tablet PCs, in which area designers are already eagerly experimenting, sometimes oscillating between game, music-making tool and musical toy.”[103]

Smartphones also rose and shared the memory problems of handhelds in the beginning. By now, they are fully functional mini-computers with respectable sound. However, the games on smartphones and handhelds have to work without sound, as the players often listen to their own playlist while playing, or play in public where sound can distract.

Electroplankton (Nintendo, 2005) is a popular handheld rhythm-action game. The player has to move planktons and make musical sounds by blowing in the microphone or using the touch-screen in ten different gameplay modes. He or she manipulates the plankton to make music.

Around 2005, the next standard of consoles was released. The Xbox 360 (Microsoft, 2005) supported 3D surround sound and allowed players to use their own playlists with a port to plug-in MP3 players. The PlayStation 3 (Sony, 2006) was able to run up to 512 audio channels and use various DSP filters and layers in real time. Streaming audio also was possible and it supported Sony's online service. The only problem on the PlayStation consoles is that audio has to share memory with graphics and game functions, therefore audio has to be compressed. The Wii (Nintendo, 2006) was a real competitor to the home consoles, as it introduced a new kind of controller. The controller was a handheld remote with motion sensors, charged with battery. The controllers have

103 Fritsch, 2012, p. 35

tiny integrated speakers that have to be used in some games. However, the sound capabilities are not comparable to the other home consoles, but due to the controlling system every game has adaptive sound.

The rise of new consoles did bring new innovative music games and games with serious, creative musical scores on the market.

BioShock (2007) included retro licensed music from the 1930s to 1950s in addition to an original score that included elements of musique concrète, twelve tone technique and aleatoric.[104]

Eternal Sonata (Namco/Tri-Crescendo, 2007) features the life and music of the famous composer Frédéric Chopin. The online mode of the zombie game Left 4 Dead (Valve South et al., 2008) includes a feature to personalize music: “the 'music engine' in *Left 4 Dead* has a complete client side multi-track system per player that is completely unique to that player and can even be monitored by spectators.”[105] The various zombie classes, furthermore, each have leitmotifs.

In 2008, another musical game was released for the Wii. Wii Music (Nintendo, 2008) challenged the player to simulate playing instruments on the remote controller.

Brütal Legend (Double Fine Productions, 2009) is based on the heavy metal culture and features its music and gives information about the culture itself.

Dance Central (Harmonix, 2010) relies on the Kinect technology that can be added to the Xbox 360. Kinect recognizes motions of the player. Therefore, the gamer has to dance without using any controller.

Def Jam Rapstar (4mm Games, 2010) is a karaoke game with a feature to make an own music video to each song. It can be recorded with an add-on to the console and edited afterwards.

Besides all those musical games, many other games were developed for every platform. Countless new innovative games, follow-ups of successful series and casual games all evolved and entered the market. Some games are even used to teach how to play an instrument (for example Rock Band 3, which was delivered with an actual MIDI guitar). Games also entered education.

104 See Fritsch, 2012, p. 32
105 Larkin, 2008

Certainly, every game would deserve to be mentioned for its music, as most of the scores are individual, creative and innovative in some way. I only mentioned those that were also mentioned in the literature to contain the scope of this thesis.

The latest standard of home consoles was released around 2013. The Wii U (Nintendo, 2012) is the follow-up to the Nintendo Wii from 2006. It is a fully functional home entertainment system, that can be used to play games alone and with friends (in combination with the classical Wii controllers), watch movies, surf on the internet, shop and socialize in the Nintendo social network. It is delivered with a special controller called GamePad, that is like a separate handheld console with a touch screen. It can be used to play and to control the console and the TV. The Wii U has at least eight gigabytes of memory and "uses six-channel PCM linear output via HDMI connector, or analog output via the AV Multi Out connector"[106].

The Xbox One (Microsoft, 2013) is a home entertainment system as well. It also contains an own network, connection to the internet, the possibility to play movies, listen to music on CDs and via online streaming services and, of course, games can be played. The Xbox One supports the Kinect technology and it can be controlled with a smartphone, tablet or controller or with voice control. The sound is adapted to the current 3D sound standards, to guarantee allround entertainment. Furthermore, it is connected to the "Cloud", an online service that stores the games on a huge server system and shares the information like graphics and sound via the internet on the player's screen. The cloud is ever-evolving, memorizing data inserted by the players and recognizing the behavior of the players and their friends.[107]

The PlayStation 4 (Sony, 2013) has similar capabilities to its competitors, but Sony is working on a reality headset the player can use to reach total immersion in the games. Furthermore, it has a wireless controller and a camera. It has eight gigabytes of integrated memory and is built with a DVD and Blu-Ray drive, and therefore supports the current 3D sound standards.[108]

All three companies have released magnificent games with epic soundtracks to attract the players and in order to pioneer in every category, including music, graphics, technology and innovation.

106 See Nintendo, c2015
107 See Microsoft, c2015
108 See Sony, c2015

Figure 15: Video Games Live, 14 march 2007, Zelda segment

Video game music, by now, is no longer only seen in video games. The music for video games evolved to be a separate serious medium. Like in 1987 in Japan, video games music currently tours as several live concert series worldwide – since 2005.

Video game music is also featured on some radio stations, in movies like “Scott Pilgrim vs. the World” and in TV series.

“The impact of video game music on today's culture cannot be ignored.”[109]

This statement was proven on February 13, 2011. The score for Civilization IV was awarded a Grammy for the “Best Instrumental Arrangement Accompanying Vocalists” as the first video game score ever.[110] By now, at the latest, video game music is not an add-on anymore, but a main part of any video game and the musical industry.

For the video game music, the last fifteen years flourished with possibilities. Due to the now nearly unlimited possibilities, the composers could use their creativity. As the industry now recognized the importance of music, the budgets are bigger as well. Therefore, the developers now use every musical genre, it completely depends on the games and companies. Everything is featured, licensed music, pre-composed sounds, original scores. Many games, especially rhythm-action games, use licensed popular music. Role playing and adventure games often use original scores composed by game composers. Many games mix both.

109 Fritsch, 2012, p. 36
110 See Fritsch, 2012, p. 37

“Soundtracks in video games have developed from isolated cues and theme tunes in classic arcade games, which often merged with the sound effects, to elaborate scores.”[111]

Nevertheless, sound effects are still an important part of every game. They typically are used in the game and in the interface.

Music in general is used always, and game music also is an important part of the marketing for a game. It is used in trailers, cutscenes and sometimes on the website as background music.

The musical structure didn't change too much in all those years of evolving. Looping is reduced to the necessary minimum. Levels are still underscored with longer sequences and boss fights have musical sequences delivering more tension. The usage of film music techniques grew significantly, due to more technical possibilities. The process of making video game music is now similar to underscoring a movie. The music immerses the player into the game world. Nevertheless, it is more challenging to create video game music. Unlike movies, they are non-linear and the music needs the ability to react to the player's performance and the game.

The importance of music became more understood in the last fifteen years. Music is a key part of every game and important for the enjoyment. It is, furthermore, an independent part of the game. A player can't play his PlayStation 2 game on his or her smartphone, but he or she can listen to the music. The gamer doesn't even need to know or have the game in order to listen to or buy the music. Video game music is more than just a functional and useful add-on and relevant for every kind of game.

With further developments in the technology, video game music became more and more interactive. By now, every game contains interactive musical parts in every possible way. Sounds happen in or outside the diegesis and their interactivity depends on the game, genre and platform. Typically, the background music is non-diegetic while the sound effects combine diegetic and non-diegetic parts that are sometimes adaptive and sometimes not. In general, however, every possible combination is used. The sound quality increased significantly and now nearly every game and console features surround sound and every game features the common musical CD and MP3 audio standards.

111 Rauscher, 2012, p. 104

3.6 Summary

> "The complexity and density of sound effects and music have developed concurrently with developments in audio and storage technology and with improvements in game graphics; concurrently, the player's engagement with sound has become more complex, demanding more of the player's attention. The simple, monophonic beeps of *Pong* have given way in many modern games to multichannel, real-time processed 3D audio and lavish orchestral arrangements of a fidelity rivaling any hi-fi recording."[112]

The role of music in video games changed significantly during the last 40 years, being pushed by players and developers.

In the early 1970s in the arcades, the sounds appearing as beeps were functional. They were delivered through customized speaker arrangements, subwoofers and playback devices in a low musical quality and only used when the game was paused. Their main purpose was to attract players in a noisy hall.

In the 1980s, the music started to be continuous through the usage of external sound chips with multiple sound channels. In 8-bit quality, the first "earworms" were composed, catching the players. The introduction of MIDI increased the creativity and the amount of instruments. The first games used adaptive Mickey Mousing to create interactivity. Music slowly received attention and began to be seen as an important part of the game.

The introduction of programs like iMuse and DirectX as well as storage devices like the CD-ROM in the 1990s enabled the last important advances. Surround sound and better sound cards nearly freed the music from limitations. By then, the music was seen as an important part of the game, its strength finally was realized – and accepted.

The new millennium showed the variety, influence and importance of video game music in every console and game released.

"Music is an essential part of the gaming experience and gaming is an essential vehicle today for music discovery."[113]

Video game music is flourishing. It fought its way from a functional add-on to a key element of enjoyment. Video games – and their music – grew up, and they plan on getting very old.

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112 Grimshaw / Tan / Lipscomb, 2013, p. 675, emphasis added
113 David Dorn in Berardini, 2004

In all those years of evolution, some characteristics remained the same and just expanded a little. Others, like the role and importance of video game music, as mentioned above, changed significantly.

The importance and role of music was entirely re-developed and accepted in an appropriate way.

The places where music is used just expanded. The use of music was only possible outside the game for “Game Over” sounds and in the interface, now the games' music is in every part of the game. Game audio today has several functions. It shall immerse the player into the game world, it can inform and forewarn the gamer about upcoming events, nearby enemies etc. It can influence the decision of a player. Turning the sound off can worsen a player's performance. Furthermore, sound is a marketing instrument, used for advertising and as bonus content.

The musical genres used also expanded significantly. Due to the fact that in early games, the music was developed by non-musicians, pre-composed music and simple melodies were used. The music was programmed into the machines, and therefore sounded more noisy than musical. Nowadays, the music is made by actual composers and whole sound design teams only employed for this part. That results in more originality, various instrumentations and elaborate arrangements that are recorded with a huge engagement in professional music recording studios with professional orchestras and musicians. Of course, some games still use pre-composed music and license popular music. The cooperation with popular music and movies in fact developed into an important marketing feature, increasing sales for both music and game.[114] The possibility to use personal music also is integrated in every console today, as players want to have the most individual systems possible.

The musical structure now totally depends on the game and its genre. In the early years of gaming, in general, there were only shooter, tennis, adventure and jump 'n' run games. Today the game genres are countless. Thus, the music and its structure depend on the genre of the game. An online MMO needs more audio than a ten hour point-and-click game. Many genres, as mentioned earlier, have epic original scores. Some use retro sounds, remembering the arcade times. Game series rely on their predecessors. Therefore, also, the musical structure varies significantly. Many games use leitmotifs and immerse the players into the game world with moody scores. Looping isn't used often anymore.

114 See Collins, 2008, p. 117ff

“From the very beginning of video games, there was a desire to increase the degree of interactivity.”[115]

In early games, interactivity wasn't worth mentioning, as the music itself wasn't regarded as an actual feature. Furthermore, interactivity wasn't possible due to the limited audio capabilities. When music got attention in the late 1970s, developers tried to create interactivity with using the film music composing technique Mickey Mousing. More technological possibilities also paved the way for the implementation of interactivity in every way. Therefore, it is now used in every game and in all its pride.

Creating an interactive score is the main difference between film and video game music today. The non-linearity challenges the composer to create a score, that can react to the player. Therefore, games music needs more parts in order to underline every possible performance with the correct and fitting musical part.

115 Moormann, 2012, p. 7

4 The future of game music

Currently, video game music has the time of its life. It is admired, seen in every media and taken seriously. And as I mentioned earlier: it is here to stay.

The video games industry is an industry that wants to explore all technological possibilities in order to become as variable and pioneering as possible. Therefore, the technology is going to improve and evolve further. Regarding audio, better sound chips and surround sound systems for casual users are going to develop – taking the audio quality with it. Accordingly, the recording technologies will also follow, creating a new standard.

“Games have driven and will continue to drive these technologies, particularly in the area of sound.”[116]

The hardware and storage systems are also going to improve, becoming faster and cheaper. The memory available for audio finally is going to be irrelevant, regarding the trend towards better, faster, wider.

Interactivity is going to develop further in order to immerse the player as much as possible. The composers and sound designers are going to try and explore various ways to make the immersion more complete.

“The future looks very promising for alleviating repetition and creating a more engaging experience for the player, as audio elements change more effectively to match the action.”[117]

The music will be timed better with the in game actions. In order to realize that, the music is going to be mixed in real time, using more and better sound effects in addition to the music.

Bigger teams for the audio are going to be necessary, in order to solve all challenges given by the audio requirements, especially in order to create a better interactivity. Therefore, more jobs are going to be developed as well. The composers, furthermore, will get more opportunities to experiment.

116 Collins, 2008, p. 83
117 Marks, 2012, p. 10

The music will become more personalized or have more options for personalization in order to satisfy the individual demands of players today.

The trend towards better sound quality and musical variety also required higher budgets for audio in video games. As the role of video games music has so significantly grown, the budgets might come after.

However, more indie games and developers are entering the market. Insofar, the music may also take a step back, as indie developers usually don't have a comparable budget to major developers like Nintendo. Therefore, the usage of MIDI, low instrumentations and retro music may increase again as well.

The music of video games will also become a more separated part, being sold as soundtracks with bonus material and touring around the world with live orchestra even more. The two documentaries mentioned in the introduction are going to be released and inspire other documentaries.

All in all, music in video games will on the one hand become more integrated in the games and in the consoles, and on the other hand become more autonomous.

As well as the music, the networking possibilities are going to expand, taking the musical streaming services with it. The latest consoles offer the possibility to network with other players, family and friends. They can also share their music and games. Regarding this development, video games are probably going to develop more independently from consoles and technological requirements and be hosted on servers. Thus, all technological limitations will be lifted and the games – and their music – might become completely free. The players then might share their music more and the music will become an even more integrated part in the multimedial world.

5 Conclusion

“The history of games, as shown, is itself nonlinear, influenced by industry, technology, and social needs, knowledge, and desires.”[118]

It is, as shown in the previous chapters, a history containing competitive and ambitious companies as well as players and developers pushing technological advances. The music of video games had to follow this trend to evolve and survive in this challenging industry. And as was shown, video games developed from zero to hero.

“The development of game audio can be seen as the result of a series of pressures of a technological, economic, ideological, social, and cultural nature.”[119]

The evolution of video games music is directly connected to and dependent on the evolution of technological advances. They made video games possible – and they allowed for the music to evolve. And as it happened with many musical genres in the music industry (Jazz, Rock 'n' Roll etc.) video games music had to earn its success.

Competitive companies are also an essential part of the video games musical history, as everyone wanted to pioneer. People pushed the music to where it is and made it autonomous.

Most authors that focus on video games or video game music order their work by bit-eras. I decided to work chronological in order to fit the timings for significant musical changes correctly and clearly. To simplify my research, I therefore designed a chronological table that shows releases of important games and consoles, that inspired or affected the music in video games. You can find that table in appendix 1.

The characteristics of video game music changed or expanded with technological possibilities. However, the player still is the most characteristic part of a video game and its music.

I myself loved video games and their music since I first played on my PlayStation in the late 1990s. What I love even more is what happened to them and how they evolved to become a serious entertainment medium. Some people are bored by the trend towards epic scores like in films, but I think it's marvelous that the players and developers didn't

118 Collins, 2008, p. 84
119 Collins, 2008, p. 6

give up on video game music and made this huge evolution from a beep to an original orchestral score possible.

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Appendix

Appendix 1: History of video games and consoles that are important for the evolution of game music

Table made by Janina Ziegler (June 2015) based on the information from:

Amazon, c1998-2015

Collins, 2008

Fritsch, 2012

Marks, 2012

Old Classic Retro Gaming, 2010

Release	Game	Console	Type	Sound information	Company
1958	Tennis for Two			No Sound	
1962	Spacewar!			No Sound	
1971	Computer Space		Arcade Game	Unwanted noise, no sound	Nutting Associates
1972	Pong		Arcade Game	Simple single-tone beep	Atari
1974	Touch Me		Arcade Game	player has to remember and repeat beep sounds	Atari
1975	Pong	Telegame home system	Home Console	Simple single-tone beep	Atari
1976		Channel F	Home Console	Internal speakers to re-play sound effects	Fairchild
1977		Video Computer System (VCS) / Atari 2600	Home Console	Stella (TIA) sound chip, 2 channels with 4-bit sound	Atari
1977		Studio II	Home Console	Capable of replaying beep sounds with varying tones and length	RCA
1977		Apple II	Home Computer	1 channel capable of beeps	Apple
1978	Space Invaders		Arcade Game	Functional sound, continuous bass-based 4-tone loop that sped up	Taito
1979		Intellivision	Home Console	PSG capable of 3-part	Mattel

				harmony	
1979	Asteroids		Arcade Game	2-note melody, usage of a PSG	Atari / Midway
1980	Space Invaders	Atari 2600	Home Console	see above	Midway
1980	Rally-X		Arcade Game	Continuous background music using looping, usage of a PSG	Namco / Midway
1980	Pac Man		Arcade Game	Cutscenes accompanied by music, usage of a PSG	Namco
1981	Frogger		Arcade Game	First game without loops due to 11 different songs, first dynamic music	Konami
1982		Atari 5200	Home Console	Pokey audio processor, 4 channels with controlled pitch, volume, distortion	Atari
1982		Commodore 64 (C64)	Home Computer	SID Chip with 3 sound + 1 noise channel, integrated synthesizer	Commodore
1982	Dig Dug		Arcade Game	Music reacts to the player's input, Mickey Mousing	Namco
1982	Journey's Escape	VCS	Home Console	Cooperation of a video game with a popular band	Atari
1983	Moondust	C64	Home Computer	Early example of a dynamic ambient score	Creative Software
1983		Famicom („Japanese NES“)	Home Console	PSG with 5 channels for music & sound effects, capable of 8 octaves, 4 duty cycle options	Nintendo
1984		PCjr	Home Computer	4 channel PSG	IBM
1984	King's Quest	PCjr	Home Computer	classical channel usage, 3 channels music 1 for noise and sound effects	Sierra On-Line
1985		Nintendo Enter-	Home Console	See Famicom	Nintendo

		tainment System (NES)			
1985	Super Mario Bros.	NES	Home Console	First game with continuous background music written by an actual composer (Koji Kondo)	Nintendo
1985	Tetris		1989 released for the Game Boy	Famous music based on a russion folk song	Nintendo
1985		Amiga	Home Computer	soundchip Paula, 4 channel 8-bit stereo sound, used DSP	Commodore
1986		Master System	Home Console	monophonic sound generators, each capable of 4 octaves	Sega
1986	Metroid	NES	Home Console	Unusual use of the sound channels, used pulse wave for bass with triangle lead	Nintendo
1986	Dragon Quest	NES	Home Console	first game with a live recorded separately sold score, first video games live concert ever in Japan	Chunsoft et al.
1986	The Legend of Zelda	NES	Home Console	One of the greatest pieces of game music ever	Nintendo
1987	Final Fantasy	NES	Home Console	Combined eastern & western musical styles	Square
1987	Dance Aerobics	NES	Home Console	Early rhythm-action game, delivered with a separate controller	Human Entertainment
1987	Maniac Mansion			Origin of the SCUMM engine	LucasArts
1988		Mega Drive	Home Console	Frequency Modulation (FM) chip	Sega
1988	Zak McKraken	C64	Home Computer	Example for the use of	LucasArts

				classical music	
1988	King's Quest IV		Home Computer	used MF-32 & AdLib chip for advanced audio, hired movie/TV composers for their games	SIERRA
1989		PC Engine / Turbo Grafx	Home Console	Dual 8-bit processor, 16-bit graphic chip, 6 channel stereo sound	NEC
1989		Genesis / MegaDrive	Home Console	classical PSG chip + FM chip with 6 channels stereo sound + PCM 8-bit sample channel	Sega
1989		Game Boy	Handheld	3+1 channel stereo sound PSG, 4th channel offering 4-bit noise (envelope generator)	Nintendo
1990	Moonwalker	Genesis and Arcades	Home Console and Arcade Game	Usage of popular music by Michael Jackson	Sega
1990		Super Famicom / SNES	Home Console	8-bit co-processor with DSP supporting 8 channels of programmable stereo sound using wavetable synthesis	Nintendo
1991	Neverwinter Nights		Home Computer	First MMORPG needing hours of music	Stormfront Studios
1991	Sonic the Hedgehog	Genesis	Home Console	Typical channel use	Sega
1991	Monkey Island 2: LeChuck's Revenge			introduction of iMuse	LucasArts
1993		FZ-1 3DO	Home Console	CD-ROM audio quality	Panasonic
1993		Jaguar	Home Console	CD-ROM audio quality	Atari
1993	Doom		Home Computer	sound effects important for the player's performance, surround sound, leitmotifs	Id-Software

1993	Myst		Home Computer	minimal ambient music & sound effects, silence as stylistic device	Cyan
1994		Saturn	Home Console	CD-ROM audio quality, two audio processors with a 16-bit DAC & and a 32-channel PCM sound generator	Sega
1994		PlayStation	Home Console	CD-ROM audio quality, 24 channels, real-time effects	Sony
1994	Rise of the Robots			popular artists involved in creating original game's soundtrack (Warner)	Time Warner Interactive
1995		Windows 95	Home Computer	Introduced DirectX/DirectMusic, which extended the power of MIDI	Microsoft
1995	Wipeout	PlayStation	Home Console	featured exclusive tracks by popular musicians	Sony
1996	Quake		Home Computer	Cooperation with Nine Inch Nails to market the game	id Software et al.
1996	Diablo		Home Computer	Tristram theme had guitar intro that was string samples more than actual synth	Blizzard North et al.
1996		Nintendo 64	Home Console	MIDI based sound, supported 16-bit CD quality & surround sound, DSP possible	Nintendo
1996	PaRappa the Rapper	PlayStation	Home Console	Player has to recreate a track pushing the controller buttons	
1996	Simtunes	Windows	Home Computer	Player created musical pictures	Maxis
1997	Beatmania		Home Console	DJ simulation game	Konami

			and Arcade Game		
1997	Lost World	PlayStation and Saturn	Home Console	first (by release date) original game soundtrack to consist entirely of a live orchestral score	Interactive
1997	Final Fantasy VII	PlayStation	Home Console	relied on MIDI and had more interactive music with smoother transitions, which wasn't typical for PS games.	Squaresoft
1998	The Legend of Zelda: Ocarina of Time	Nintendo 64	Home Console	game with interactive musical sequences within the game + dynamic music	Nintendo
1998	Heart of Darkness			first (by recording date) original game soundtrack to consist entirely of a live orchestral score	Amazing Studio
1998		Dreamcast	Home Console	2 sound processors with own memory, samples did not have to be decompressed	Sega
1998	Dance Dance Revolution		Arcade Game	Brought rhythm-action into the arcades	Konami
1999	Silent Hill	PlayStation	Home Console	Usage of electronic music	
1999	Tony Hawk's Pro Skater			Usage of licensed hip-hop music	Neversoft
1999	VIB Ribbon	PlayStation	Home Console	Used the PS's feature to play back CD music from any CD the user put in to create levels	NanaOn-Sha
1999	Space Channel 5			Player has to repeat dance sequences, usage of popular music	united game artist et al.
2000		PlayStation 2	Home Console	First DVD drive, 16-bit	Sony

				CD audio quality, surround sound, additional 48 MIDI channels	
2000	The Sims		Home Computer	Player could select music/background sound	Maxis
2001		Game Cube	Home Console	16-bit CD audio quality, surround sound	Nintendo
2001		Xbox	Home Console	Audio processor SoundStorm, 64 voice audio processor, 64 MB unified memory, 200 MHz bandwidth	Microsoft
2001	Rez		Home Computer	Replaced sound effects with electronic music	United game artists et al.
2001	Grand Theft Auto 3	PlayStation 2	Home Console	In-game radio stations, where the music could be manipulated	Rockstar Games
2003	Donkey Konga	Game Cube	Home Console	Delivered with bongos	Namco
2004	SingStar	PlayStation 2	Home Console	Delivered with a USB microphone	London Studio
2004		Nintendo DS	Handheld	MIDI, tracker & sampling software, virtual stereo speakers, built-in microphone, 16 channels	Nintendo
2004		PSP	Handheld	3D multichannel sound, integrated stereo speakers	Sony
2004	Halo 2		Home Computer	Separately sold original score	Sumthing Else Music
2004	World of Warcraft		Home Computer	MMORPG with an original, epic score	Blizzard Entertainment
2005	Guitar Hero		Home Console	Delivered with a guitar	Harmonix Music Systems
2005		Xbox 360	Home Console	3D sound, players can use own music	Microsoft

2005	Electroplankton	Nintendo DS	Handheld	Player has to create music.	Nintendo
2006		PlayStation 3	Home Console	512 audio channels, DPS filter and layering in real-time	Sony
2006		Wii	Home Console	tiny speakers in the controller	Nintendo
2007	Rock Band		Home Console	Delivered with several instruments	Harmonix et al.
2007	BioShock	PlayStation 3 and Xbox 360	Home Computer and Home Consoles	Combines old licensed music with an original score	2K Games
2007	Eternal Sonata	PlayStation 3 and Xbox 360	Home Computer and Home Consoles	Reference to famous composer Chopin	Namco/Tri-Crescendo
2008	Left 4 Dead	Xbox 360	Home Computer and Home Consoles	Personalized music and usage of leitmotifs.	Valve South et al.
2008	Wii Music	Wii	Home Console	Simulation of playing an instrument	Nintendo
2009	Brütal Legend	PlayStation 3 and Xbox 360	Home Computer and Home Consoles	Reference to the Heavy Metal culture & music	Double Fine Productions
2010	Def Jam Rapstar	Wii and PlayStation 3	Home Console	karaoke game	4mm games
2010	Dance Central	Xbox 360	Home Console	Full-body dance game, popular music	Harmonix Music Systems
2012		Wii U	Home Console	6 channel PCM linear output, supports 3D sound standard	Nintendo
2013		Xbox One	Home Console	supports 3D sound standard	Microsoft
2013		PlayStation 4	Home Console	supports 3D sound standard	Sony

Declaration of Originality

I hereby declare that this thesis represents my original work and that I have used no other sources except as noted by citations.

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This thesis wasn't submitted to any examination authority in this exact or any similar form.

Bönnigheim, June 22nd, 2015 Janina Ziegler